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DR. W. J. BEAL'S SEED-VIABILITY EXPERIMENT

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In the autumn of 1879, Dr. Beal began an experiment to test the viability of the seeds of some of the more common plants growing in the vicinity of the Agricultural College at East Lansing, Michigan. Most of the seeds were those of common weeds. The first account of the experiment appeared in the *Botanical Gazette* for August, 1905. This gave the results for the first twenty-five years. In the 17th Report of the Michigan Academy of Science (1915) the results were published up to the fall of 1914.

The nature of the experiment is best indicated by Dr. Beal himself, from whom I quote. He says:

I selected fifty freshly grown seeds from each of twenty-three different kinds of plants. Twenty such lots were prepared with the view of testing them at different times in the future. Each lot or set of seeds was well mixed in moderately moist sand, just as it was taken three feet below the surface, where the land had never been plowed. The seeds of each set were well mixed with the sand and placed in a pint bottle, the bottle being filled and left uncorked, and placed with the mouth slanting downwards so that the water could not accumulate about the seeds. These bottles were buried on a sandy knoll in a row running east and west and placed fifteen paces northwest from the west end of the big stone set by the class of 1873. A boulder stone, barely even with the surface soil, was set at each end of the row of bottles, which were buried about 20 inches below the surface of the ground.

As table 2 shows, a bottle containing a set of seeds has been dug up every five years and tested for germination. Results are now at hand for forty years, and there are still twelve sets buried, or enough to last sixty more years if the same rate of testing is followed. Dr. E. A. Bessey, under whose direction the last two tests have been made, has suggested that the interval of testing be lengthened to ten years, thus increasing by sixty years the duration of the experiment.

Dr. Beal made all the tests up to and including 1909, the thirtieth year. The tests fall due in the fall, and the 1914 test was made at that time. The last test, however, was made in the spring of 1920, because the test had been delayed until the ground had frozen so hard as to make it impossible to dig up a bottle. The rather unusual results of the last test, however, have suggested that the wintering-over due to this delay has been rather fortunate than otherwise. The showing made was much better than that of 1914. Several factors may have contributed to this.

The method of testing the last time, which was essentially that of 1914, was as follows: The equipment consisted of two flats about 18 x 20 x 2½ inches deep. These were nearly filled with rich sifted loam, sterilized at

10-12 pounds' pressure for three hours. One of the flats was used for growing check seeds of the same species which had succeeded in germinating during the last fifteen or twenty years. With checks of this kind it is very easy to identify very young seedlings, which is indispensable for recording the number that start to germinate. The flats being in readiness, the sand from the bottle dug up was spread evenly over the surface in one of the flats and mixed slightly. Seeds were at once planted in the other flat and labeled, each species being kept in a small area of its own. This was on March 27. The flats were kept in a semi-shady place in the greenhouse at a temperature of about 22° C. They were watered once daily with a fine spray. The species planted in the check flat were as follows, being arranged here in the order in which they came up: *Brassica nigra*, *Bursa bursa-pastoris*, *Anthemis cotula*, *Alsine media*, *Lepidium virginicum*, *Amaranthus retroflexus*, *Chaetochloa lutescens*, *Portulaca oleracea*, *Oenothera biennis*, *Rumex crispus*. These all made a good growth and were kept properly labeled.

The first of Dr. Beal's seeds to germinate was *Brassica nigra*. By May 7, 9 individuals of this species had come up and were identified. Having made good growth (2-3 inches), they were removed to allow room for other species. Possibly the second plant to appear was *Chenopodium album*, two plants of which had appeared by May 7, and were identified beyond question. Strangely, this species was not mentioned as being in the set. At about the same time two individuals of ragweed (*Ambrosia elatior*) were identified. By May 22, there were nineteen seedlings of *Oenothera biennis*, some of these being 3 inches high, nine seedlings of *Rumex crispus* about 4 inches high, one plant of *Portulaca oleracea* with the third pair of leaves developed, one plant of *Lepidium virginicum* with one pair of leaves besides the cotyledons developed, five plants of *Plantago major*, some up to 3 inches tall, one plant of *Amaranthus retroflexus*, and thirty-three plants of *Amaranthus* sp. (probably *A. graecizans*).

Among the twenty-three species which Dr. Beal buried, he included *Juglans nigra*, *Quercus rubra*, and *Thuja occidentalis*. He says that the first two were not put in the bottles, and I have found no evidence to show that the *Thuja* was put in with the smaller seeds. This leaves twenty species that were put in bottles, or a total of one thousand small seeds in each bottle. With this number of seeds in each bottle it can easily be seen that, unless great care was taken, a few seeds other than those intended might easily be put in the sets. This, I believe, might account for some of the irregularities observed. The amaranth seeds in this bottle were evidently meant to be those of *A. retroflexus*, but thirty-three out of the thirty-four specimens of amaranth seedlings observed seemed to be *A. graecizans*. The percentage of germination for the genus *Amaranthus* was therefore, in this case, 68 percent after an interval of 40 years. The irregularity in connection with *Chenopodium album* may be due to the great similarity between the seeds of *Chenopodium* and those of *Amaranthus*. Table 1

gives a summary of those seeds which germinated, with the number of individuals in each case and the percentage of germinations.

TABLE 1

Name of Plant	Number of Individuals	Percentage of Germination
<i>Brassica nigra</i>	9	18
<i>Oenothera biennis</i>	19	38
<i>Rumex crispus</i>	9	18
<i>Portulaca oleracea</i>	1	2
<i>Plantago major</i>	5	10
<i>Amaranthus retroflexus</i>	1	2
<i>Amaranthus graecizans</i>	33	66
<i>Lepidium virginicum</i>	1	2
<i>Ambrosia elatior</i>	2	4
(<i>Chenopodium album</i>).....	2	

TABLE 2

Name of Species Tested	5th Yr.	10th Yr.	15th Yr.	20th Yr.	25th Yr.	30th Yr.	35th Yr.	40th Yr.
<i>Amaranthus retroflexus</i>	+	+	+	+	+	+	0	+
<i>Ambrosia elatior</i>	0	0	0	0	0	0	0	+
<i>Brassica nigra</i>	0	+	+	+	+	+	+	+
<i>Bromus secalinus</i>	0	0	0	0	0	0	0	0
<i>Bursa bursa-pastoris</i>	+	0	+	+	+	+	+	0
<i>Erechtites hieracifolia</i>	0	0	0	0	0	0	0	0
<i>Euphorbia maculata</i>	0	0	0	0	0	0	0	0
<i>Lepidium virginicum</i>	+	+	+	+	+	+	+	+
<i>Lychnis githago</i>	0	0	0	0	0	0	0	0
<i>Anthemis cotula</i>	+	+	0	0	+	0	?	0
<i>Malva rotundifolia</i>	+	0	0	+	0	0	0	0
<i>Oenothera biennis</i>	+	+	+	+	+	+	0	+
<i>Plantago major</i>	0	0	+	0	0		0	+
<i>Polygonum hydropiper</i>	0	+	+	+	+	possibly	0	0
<i>Portulaca oleracea</i>	0	+	+	+	+	0	0	+
<i>Rumex crispus</i>	+	?	+	+	+	+	+	+
<i>Chaetochloa lutescens</i>	+	+	+	0	+	+	0	0
<i>Alsine media</i>	+	+	+	+	+	+	0	0
<i>Trifolium repens</i>	0	0	0	0	0	0	0	0
<i>Verbascum thapsus</i>	+	?	+	+	0	0	+	0
(<i>Amaranthus graecizans</i>).....								+
(<i>Chenopodium album</i>).....								+

The total number of seedlings from one thousand seeds was eighty-two. The total percentage of germination was, therefore, at least 8.2 percent. It might be reasonably supposed that the real percentage of germination was even higher than this. Table 2 shows the results for forty years. From this it appears that *Lepidium* is the only species which has an unbroken record for every observation. From this latest test, *Amaranthus* certainly makes the best showing, with *Oenothera* second and *Brassica nigra* and *Rumex crispus* third. The facts that *Ambrosia elatior* had never been made to germinate before, and that *Plantago major* had germinated

only once, would seem to indicate that conditions for germination were especially favorable. On the other hand, the question arises why *Bursa bursa-pastoris* and *Chaetochloa lutescens*, each of which have failed only once, failed to germinate. Table 2 gives the complete results of the experiment up to the spring of 1920.

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